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CASE REPORT

Modified toggle pin technique combined with prosthetic capsular reconstruction for surgical stabilization of coxofemoral luxation in a Shetland pony

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Abstract

Objective: To describe open reduction and surgical stabilization of a coxofemoral luxation in a pony using a modified toggle pin technique and prosthetic joint capsule reconstruction without osteotomy of the greater trochanter.

Animal: A 2-year-old Shetland pony with a bodyweight of 167 kg.

Study design: Case report.

Methods: Radiographic examination confirmed craniodorsal luxation of the left coxofemoral joint. An open reduction with the aid of a pulley system was performed. A toggle pin was inserted through a bone tunnel extending from the level of the femoral shaft through the femoral head and the center of the acetabulum for the pin to be positioned on the medial wall of the acetabulum. FiberWire was subsequently passed through the cranial and caudal aspects of the acetabulum as well as a transverse tunnel in the femoral neck in a figure of 8 to facilitate capsular reconstruction. The pony was placed in a sling for 8 weeks and gradually returned to normal activity over 2 months.

Results: Postoperative radiographic examination confirmed the position of the femoral head in the acetabulum with the implants in place. On 2-year follow-up the pony was sound at walk and trot.

Conclusion: A combined intra- and extra-articular stabilization technique for coxofemoral luxation in a pony resulted in successful long-term reduction and excellent outcome.

1 | INTRODUCTION

Coxofemoral luxations are a rare occurrence in equids affecting mainly young horses, ponies or miniature horses.[1–5] The most common causes include trauma, upward fixation of the patella[6,7] and complications during recovery from general anesthesia.[8] Full hindlimb casts[9] and infectious causes[10] predispose to coxofemoral luxation in foals. The diagnosis of coxofemoral luxation is based on the physical examination and confirmed with standard radiographs.[11,12]

Treatment options include closed and open reduction. Whilst closed reduction attempts are more likely to be

FIGURE 1 Craniodorsal luxation of the left femoral head in a 167 kg pony. Note the outward rotation as well as the shortened appearance of the left hindlimb.

successful in acute cases seen within 12 h of injury, the failure rate is described to be as high as 80% in horses.[1,3,5,13,14] Reported positive outcomes following open reduction are limited to equids with a bodyweight of up to 230 kg to date. Published surgical techniques include excision arthroplasty of the femoral head[13–15] and capsulorraphy,[16] prosthetic capsule technique,[17] total hip arthroplasty[18] or a combination of toggle pin fixation, prosthetic capsular reconstruction and transposition of the greater trochanter of the femur.[3] Based on the low prevalence of coxofemoral luxations in horses an evidence-based treatment recommendation including a direct comparison of surgical techniques is difficult to obtain.[5] However, as the successful outcome following surgical repair appears to be strongly related to the stability of the construct and the invasiveness of the surgery, the authors developed a new surgical technique combining a modified toggle pin technique and a prosthetic joint capsule reconstruction without greater trochanter osteotomy for surgical stabilization of the coxofemoral joint in a small equid.

2 | MATERIALS AND METHODS

2.1 | History and diagnosis

A 2-year-old (167 kg) Shetland pony presented with grade 5/5 AAEP left hindlimb lameness and intermitted upward fixation of the patella. Additionally, there was mild external rotation of the left hindlimb with a shortened appearance of the limb as the tuber calcanei was located further proximal when compared to the right-hand side (Figure 1). Standing radiographs of the left coxofemoral joint were obtained (90 kV, 14.4 mAs) (GIERTH HF 400; GIERTH X-Ray international GmbH) and confirmed the diagnosis of a craniodorsal coxofemoral luxation (Figure 2).

2.2 | Surgery

Flunixin-meglumine (1.1 mg/kg BW IV) and broad-spectrum antimicrobials were administered preoperatively. Xylazine (0.8 mg/kg BW IV), butorphanol (0.025 mg/kg BW IV), diazepam (0.05 mg/kg BW IV) and ketamine (2.2 mg/kg BW IV) were used for premedication and induction of general anesthesia, respectively. General anesthesia was maintained with isoflurane (minimum alveolar concentration 0.7%) and xylazine (0.8 mg/kg/h IV). Following induction, the pony was positioned in right lateral recumbency, and girth straps were used to secure the body on the operating table. The left hindlimb was attached to a pulley system to facilitate traction on the limb and aid reduction of the luxation.

Following aseptic preparation, a 15-cm curvilinear skin incision was made in a proximodistal direction, centered over the left coxofemoral joint. The superficial gluteal and biceps femoris muscles were separated and deeper dissection was continued towards the craniodorsal aspect of the great trochanter of the femur. The middle gluteal muscle was retracted dorsally, and the insertion of the accessory gluteal muscle was transected.[17] Partial incision of the gluteus profundus muscle facilitated exposure of the luxated joint without performing greater trochanteric osteotomy. A Finochietto wound retractor was applied to improve access to the affected anatomical structures.

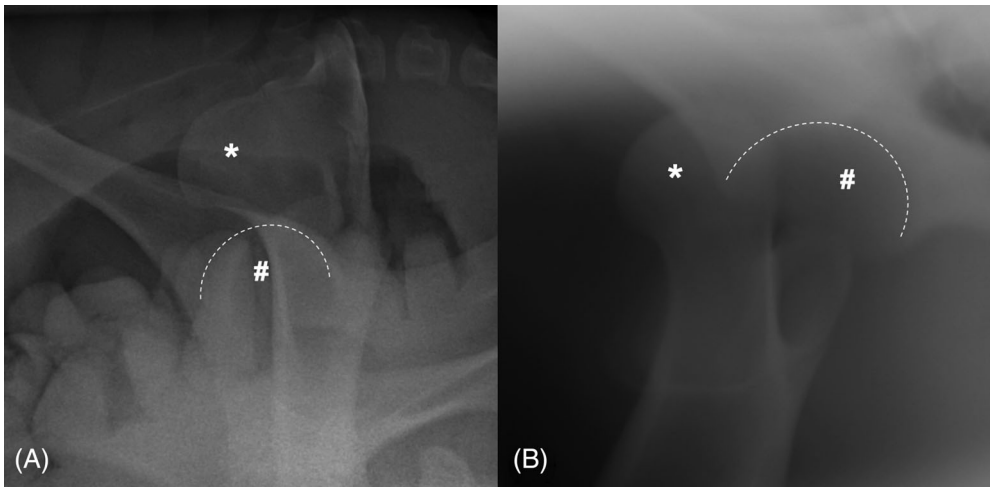

FIGURE 2 Preoperative radiographs of the left coxofemoral joint. (A) Right lateral 30° dorsal-lateroventral oblique projection. (B) Cranioventral-caudodorsal oblique radiograph. *, femoral head; #, acetabulum; dotted line, bony margin of the acetabulum.

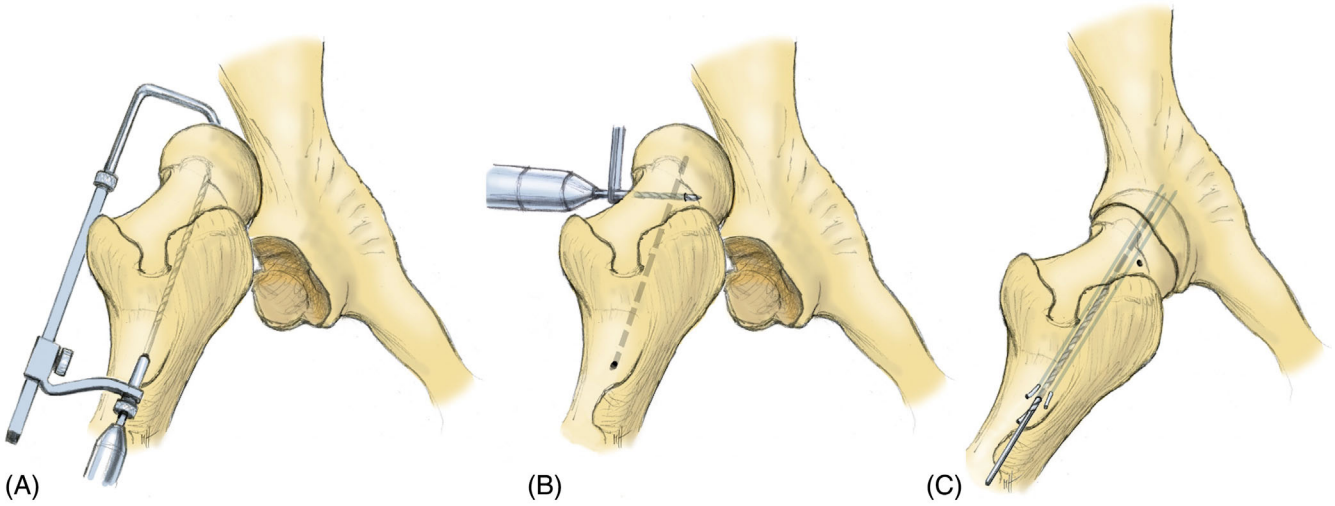

FIGURE 3 Initial surgical steps (©Matthias Haab). (A) A hole in the femur for implantation of the toggle pin construct is created with the help of an aiming device prior to reduction of the coxofemoral luxation. (B) For prosthetic joint capsule reconstruction a 3.2 mm drill hole is created horizontally across the femoral neck in a craniocaudal direction. (C) The luxation of the femoral head is reduced and three K-wires are inserted parallel to the previously created 5.5 mm drill hole through the femoral neck and head with the limb kept in neutral position.

Prior to reduction of the luxation several steps necessary for both the toggle pin fixation and the reconstruction of the joint capsule were performed. First, a hole was created in the femur for subsequent implantation of the toggle pin construct. For this purpose, a 4.5 mm hole was drilled from a point located 1 cm proximal to the third trochanter and just cranial to the caudolateral ridge of the femur towards the dorsal aspect of the fovea capitis of the femoral head with the help of an aiming device (DePuy Synthes Companies) (Figure 3A). This hole was enlarged with a 5.5 mm drill bit and flushed. A 3.2 mm drill hole was then created horizontally across the femoral neck in a craniocaudal direction for subsequent prosthetic joint capsule reconstruction (Figure 3B).

At this stage the craniodorsal luxation of the femoral head was reduced under visual control with aid of the pulley system and the left hindlimb fixed in a physiological neutral position. To continue with implantation of the toggle pin, three 1.2 mm K-wires were inserted parallel to the previously created 5.5 mm drill hole through the femoral neck and head, across the coxofemoral joint and into the acetabulum. The K-wires were crucial to stabilize the femoral head in the acetabulum and counteract rotational displacement during the following steps of toggle pin implantation. The 5.5 mm drill bit was reinserted in the 5.5 mm hole to act as a guide during implantation of the K-wires (Figure 3C). The 5.5 mm drill bit was reattached to the drill and advanced through the acetabular medial wall. The advancement of drilling was performed

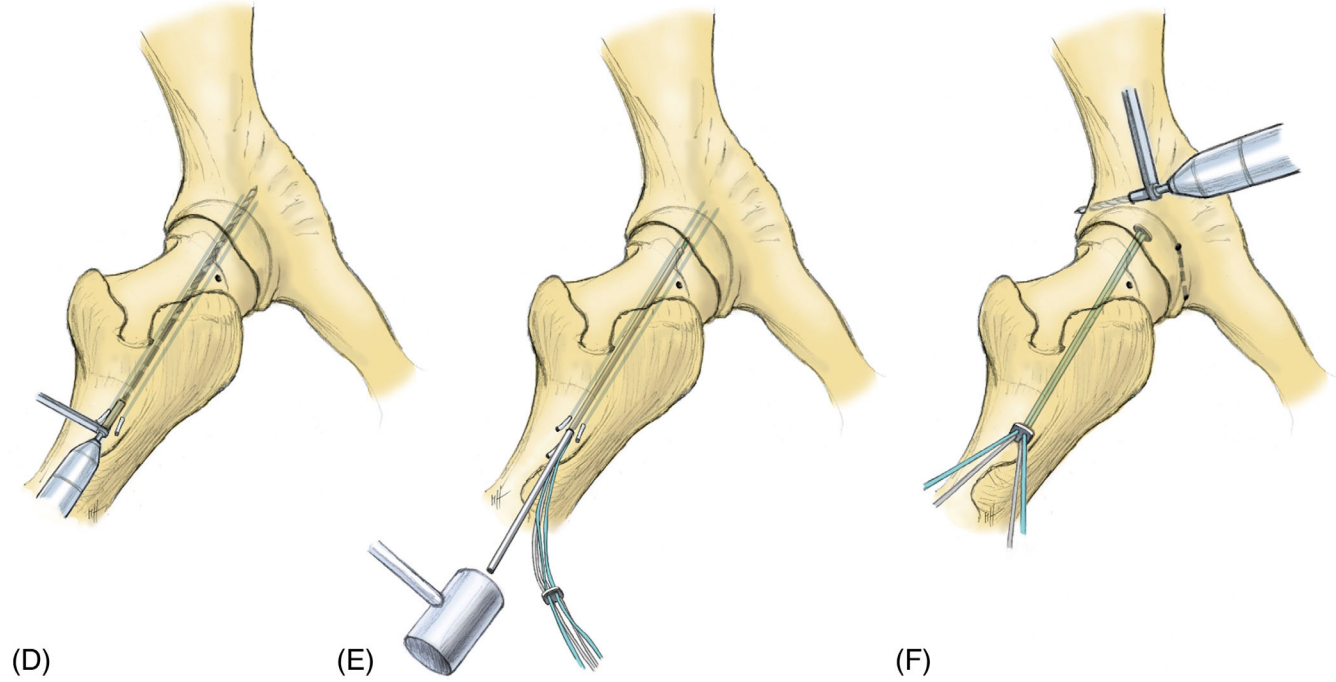

FIGURE 4 Main surgical steps (©Matthias Haab). (D) The 5.5 mm drill bit is advanced across the joint and through the acetabulum including the axial cortex of the Os ileum. (E) A blunt 3 mm pin and a mallet are used to push the toggle pin construct into the 5.5 mm hole until it passes the acetabulum. (F) Following removal of the pin, tension is placed on the construct to position the toggle pin axial against the acetabulum. Two additional 3.2 mm holes are created to complete the prosthetic joint capsule reconstruction, one in the cranial and one in the caudal aspect of the dorsal acetabulum.

with care to avoid penetration of soft tissues axial to the os ileum (Figure 4D). After lavage of the drill hole, a blunt 3 mm pin and a mallet were used to push the toggle pin construct (TightRope CCL; Arthrex GmbH) through the 5.5 mm hole until it passed the acetabulum (Figure 4E). The toggle pin construct consisted of a 3.0 mm diameter toggle pin with two multistrand, long chain ultra-high molecular weight polyethylene core (UHMWPE) suture tapes with a braided jacket of polyester (FiberTape and TigerTape; Arthrex GmbH) attached. The blunt 3 mm pin was subsequently removed, and some tension was placed on the construct to ensure that the toggle pin rotated transversely and was fixed axial to the acetabulum. After implantation of the toggle pin construct, the 1.2 mm K-wires were removed.

A prosthetic joint capsule reconstruction was performed with two additional 3.2 mm holes drilled through the cranial and caudal aspect of the dorsal acetabulum, at a distance of approximately 1–1.5 cm to the acetabular rim (Figure 4F) at the 10:00 and 2:00 o'clock position. Two USP 5 UHMWPE sutures with a braided jacket of polyester and UHMWPE (FiberWire; Arthrex GmbH) were first passed through the holes close to the rim of the acetabulum and then through the hole in the neck of the femur in a figure of 8 pattern (Figure 5G) with the aid of a nitinol suture retriever (Arthrex GmbH) as well as mosquito forceps. One figure of 8 included the hole at the cranial aspect of the acetabulum and a second suture was placed through the hole in the caudal acetabulum. Both sutures were passed through the same tunnel in the femoral neck to complete the fixation.

As the bone around the caudal hole in the acetabulum appeared weak, an anchor suture was added to reinforce stability at the caudolateral aspect of the prosthesis. For this purpose, a 3.5 mm Swivelock PEEK bone anchor screw (Arthrex GmbH) was placed at the lateral aspect of the dorsal acetabular rim, between the cranial and the caudal holes that had previously been drilled for suture placement (Figure 5I). FiberWire was attached to the anchor screw and threaded through the hole in the femoral neck in a craniocaudal direction. The sutures of the capsular prosthesis were tied with surgeon's knots and tightened on the lateral aspect of the femoral neck with the limb in an abducted position.

Finally, the toggle pin suture was tied over a 4-hole 7.5 × 12 mm button (Arthrex GmbH) to secure the pin towards the medial wall of the acetabulum with the limb in neutral position. During suture tying, tension on the toggle pin construct was controlled by use of a tension device set at 100 N (Arthrex GmbH) (Figure 5H,I).

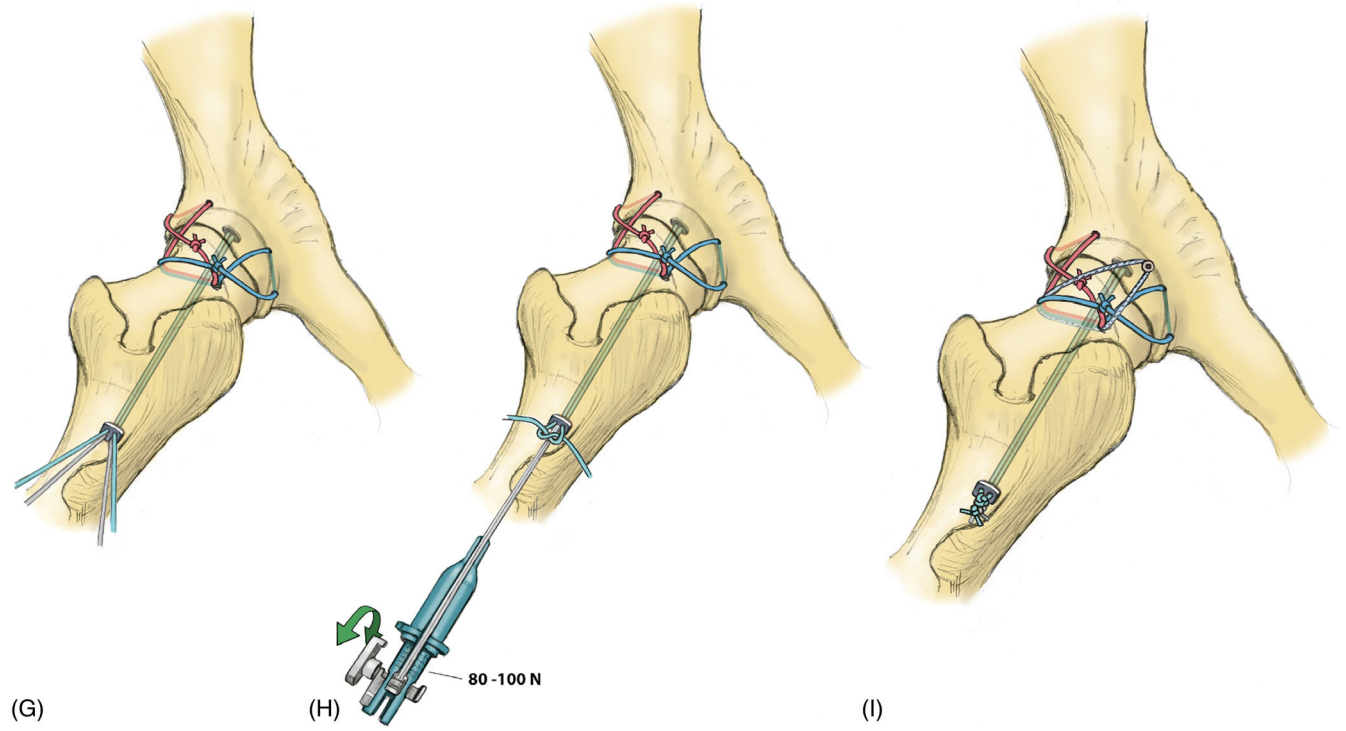

FIGURE 5 Final surgical steps (©Matthias Haab). (G) Two FiberWires are passed through the holes close to the rim of the acetabulum and then through the hole in the neck of the femur in a figure of 8 pattern. One FiberWire passes through the hole at the cranial aspect of the acetabulum (red suture) and one FiberWire passes through the hole in the caudal acetabulum (blue suture). These sutures serve as a capsular prosthesis and are tied with the limb in an abducted position. (H) The toggle pin suture (green) is tied over a 4-hole button to secure the pin towards the medial wall of the acetabulum with the limb in neutral position. A tension device set at 100 N is used to control the tension on the toggle pin construct as the suture is tied. (I) Final construct showing modified toggle pin technique with prosthetic coxofemoral joint capsule reconstruction and the additional anchor screw.

Prior to closure the surgical site was lavaged with sterile polyionic fluids. Wound closure included apposition of the deep gluteal and superficial gluteal muscles (USP 5 polyglactin 910), subcutis (USP 2-0 poliglecaprone 25) and skin (USP 2-0 polypropylene) in simple continuous fashion. Desmotomy of the medial patellar ligament was subsequently performed through a vertical skin incision over the mediodistal aspect of the ligament to prevent upward fixation of the patella and reduce the risk of reluxation after surgery. The incision was closed in simple interrupted pattern (USP 2-0 polypropylene). The surgical site was protected with a stent bandage. Hand-assisted recovery was uneventful.

2.3 | Postoperative care

After recovery the pony was placed in a sling (PM Swinglifter Version 2012; Michael Puhl GmbH) for 8 weeks to prevent it from lying down and reduce the risk of reluxation.

One week after surgery the rectal temperature increased to 40.2°C and blood hematology identified an increased white blood cell count of 18 000 cells/μl. There were no signs of inflammation at the surgical site. Thrombophlebitis of the left jugular vein was diagnosed, and antimicrobial therapy was continued for 12 days. Oral phenylbutazone was administered for 10 days in a tapering dose (4.4–3.3 mg/kg twice daily). Additionally, the pony received intramuscular morphine for 7 days (0.1 mg/kg IV every 6–8 h) and omeprazole (2 mg/kg once daily orally) during hospitalization.

Four weeks after surgery in-hand walking was introduced for approximately 2–3 minutes once a day. The horse was removed from the swinglifter 8 weeks postoperatively. The function of the left hindlimb continued to improve with rehabilitation and increased episodes of walking exercise over the following weeks.

The pony was discharged from the hospital approximately 10 weeks after surgery. The owners were instructed to keep the pony on box rest for the coming 4 months. In-hand walking was recommended for 5 minutes twice daily and to be increased by 5 minutes every other week, up to 45 minutes for the following 4 months.

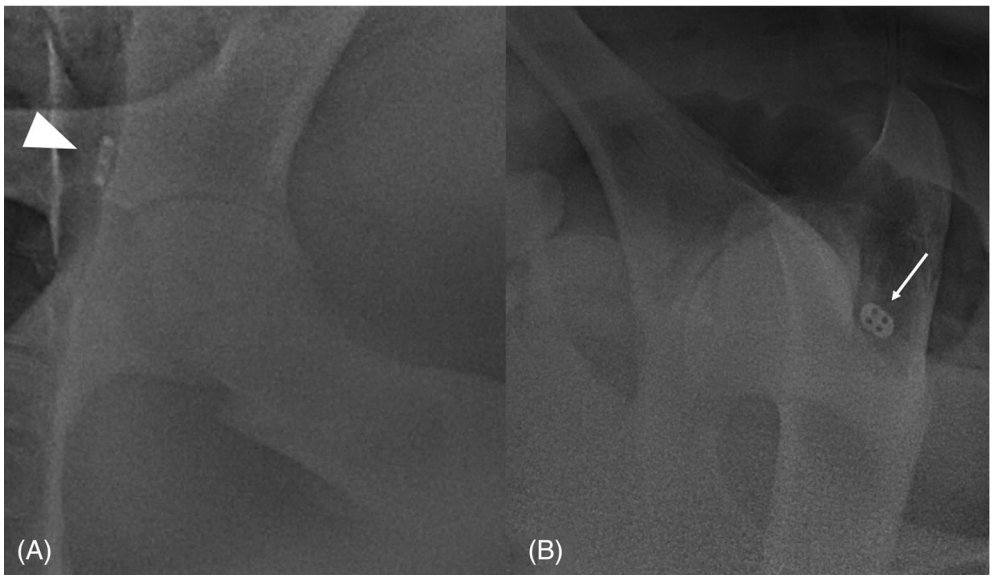

FIGURE 6 Postoperative radiographs. (A) Cranioventral-caudodorsal oblique projection centered on the coxofemoral joint showing the femoral head in the acetabulum. The white arrowhead indicates the toggle pin at the medial aspect of the acetabulum. (B) Right lateral 30° dorsal-lateroventral oblique projection of the left coxofemoral joint. The white arrow indicates the 4-hole button positioned on the femoral shaft where the knot at the end of the toggle pin construct was tied.

3 | RESULTS

3.1 | Clinical outcome

The pony was bearing full weight on the left hindlimb immediately after surgery. The wound stent was removed 6 days after surgery and there was no evidence for wound swelling or exudation. The skin sutures were removed 14 days after surgery and postoperative radiographic examination confirmed that the femoral head had remained in the acetabulum and the stainless-steel implants were in place (Figure 6).

3.2 | Follow-up

Two years after surgery the pony was sound at walk and trot (Appendix S1). There was no obvious swelling or muscle atrophy present in the left gluteal area. The left hindlimb was in a physiological position without external rotation or shortened appearance of the limb.

4 | DISCUSSION

This report describes the successful surgical treatment of a coxofemoral luxation in a 167 kg pony with a new technique combining a prosthetic reconstruction of both round ligament and joint capsule without trochanteric osteotomy. The successful outcome is likely related to increased stability of the prosthetic reconstructions and a less invasive approach compared to previous techniques.[14–16,18] Other techniques such as excision arthroplasty of the femoral head have been performed in horses with a bodyweight of up to 230 kg.[4,14,16,19] However, horses treated this way remain chronically lame and deformities of the contralateral limb may additionally occur.[16] Alternatively total hip arthroplasty as performed in small animals might be considered,[18,20] although this option is feasible only in very small equids.[18]

The technique described in this case report is novel as the hip toggle was successfully performed without a trochanteric osteotomy. Exposing the acetabulum to drill the tunnel and pass the toggle requires significant caudal and translational manipulation of the femur in dogs and cats,[21] which has been reported only in miniature horses.[3] The critical steps to avoid iatrogenic damage to the acetabular cartilage without an extensive approach was to drill the acetabulum through the femoral bone tunnel following temporal fixation of the femur in the acetabulum with the aid of additional K-wires. By using this approach, it was possible to ensure the correct alignment of both tunnels and to reduce surgery time.

Whilst coxofemoral luxations are rare in equids most cases are described to be of traumatic origin.[1–3,5] The pony in the presented case showed upward fixation of the patella during initial examination. This finding has been previously discussed as a cause as well as a result of coxofemoral joint luxation.[1,6,7,11] Based on the history it is not possible to exactly determine, but the authors suspect the upward fixation of the patella to be a secondary sequela in this particular case. Medial patellar ligament desmotomy was performed during surgery to decrease the risk of reluxation.[17]

Another advantage of the described technique is to perform capsular reconstruction without the need for suture anchoring implants, which are at high risk of pull-out in horses.[12] A fixation via bone tunnels was chosen

in the described case because of the bone stock available in this region and also the ability to use larger prosthetic sutures. Another advantage was the distance between the bony surface and the FiberWire, which might decrease creep of the suture.[3,17,22,23] Furthermore, this technique included both cranial and caudal bone tunnels to better reconstruct the function of the joint capsule. An additional knotless bone anchor was placed at the lateral aspect of the acetabulum as the caudal rim of the acetabulum appeared affected by the initial trauma.

In the postoperative period it is imperative to reduce the risk of reluxation. In small animals, Ehmer slings serve this purpose and are usually well tolerated.[24] Whilst there are some reports of the use of modified Ehmer slings in small horses, the risk of reluxation,[1,6] supporting limb laminitis and lack of patient compliance appear to be high.[25] The pony was placed in a sling in the presented case in order to prevent it from lying down. The authors consider the risk of reluxation to be particularly high when a horse rises from sternal recumbency, and a previous report supports the use of a sling for the management of a pony following hip joint luxation.[25]

Due to the fact that coxofemoral joint luxation in equids and cases which were successfully treated by internal fixation are rare, little is known about the risk of postsurgical osteoarthritis. In the authors' opinion, different facts including the initial joint damage, the correct replacement of the femoral head in the acetabulum and the stability of the implants may have an impact on the development of osteoarthritis. A case report by Clegg et al. describes a Shetland pony with coxofemoral luxation following upward fixation of the patella.[6] The pony was successfully treated by closed reduction and recovered in an Ehmer sling but developed severe osteoarthritis due to chronic mild persistent coxofemoral subluxation. In the case described here initial joint damage was less, postoperatively the femoral head was positioned within the acetabulum and the implants appeared to be stable. The authors therefore presume that the risk of osteoarthritis is reduced provided the construct remains stable.

To the best of the authors' knowledge this is the first report describing successful surgical management of a coxofemoral luxation in a horse with a bodyweight of >150 kg. The modified toggle pin technique in combination with cranial and caudal prosthetic joint capsule reconstruction achieved stabilization of the femoral head in the acetabulum and resulted in an excellent long-term outcome. The next step required is to perform the surgery in a larger number of horses, potentially with higher bodyweight, to determine the stability of the construct and develop an evidence-based treatment recommendation for horses with coxofemoral luxation.

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CONFLICT OF INTEREST

A. Pozzi is a consultant, instructor and receives royalties from Arthrex. The other authors have no financial or personal relationships that could inappropriately influence or bias the content of the paper.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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